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APPLICATIONS(U) ENGINEERING AND ECONOMICS RESEARCH INC  
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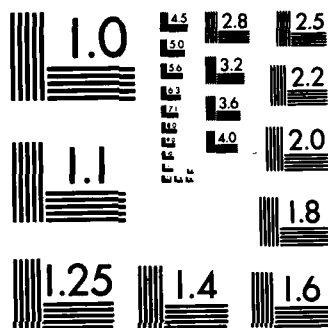
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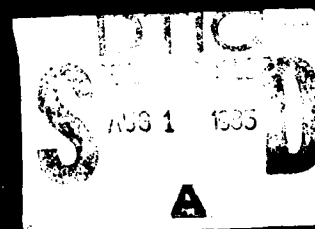
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**ENHANCED  
AIRPORT SURFACE  
DETECTION EQUIPMENT  
APPLICATIONS  
TASK GROUP 4-6.1  
STAFF STUDY**

The following report represents the views of the National Airspace Review Enhancement Task Group 4-6.1 concerning its task assignment, "Enhanced Airport Surface Detection Equipment Applications."

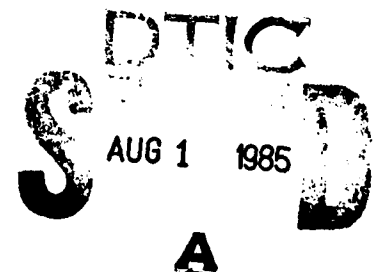


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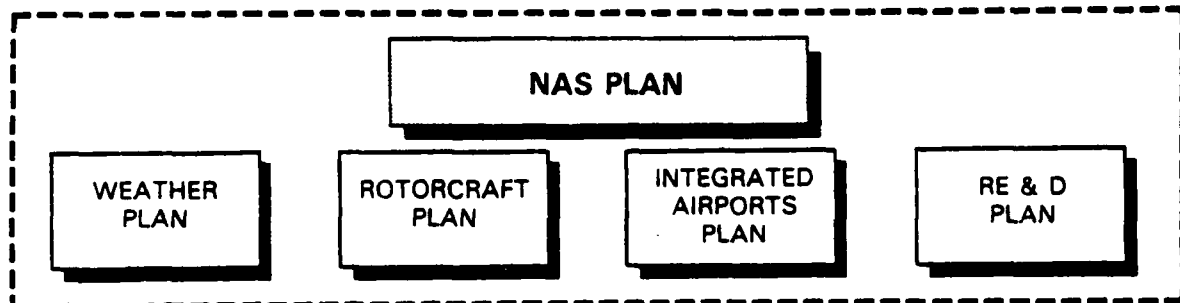


Prepared by Mr. Henry R. Schramm  
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April 17, 1985

# NATIONAL AIRSPACE SYSTEM

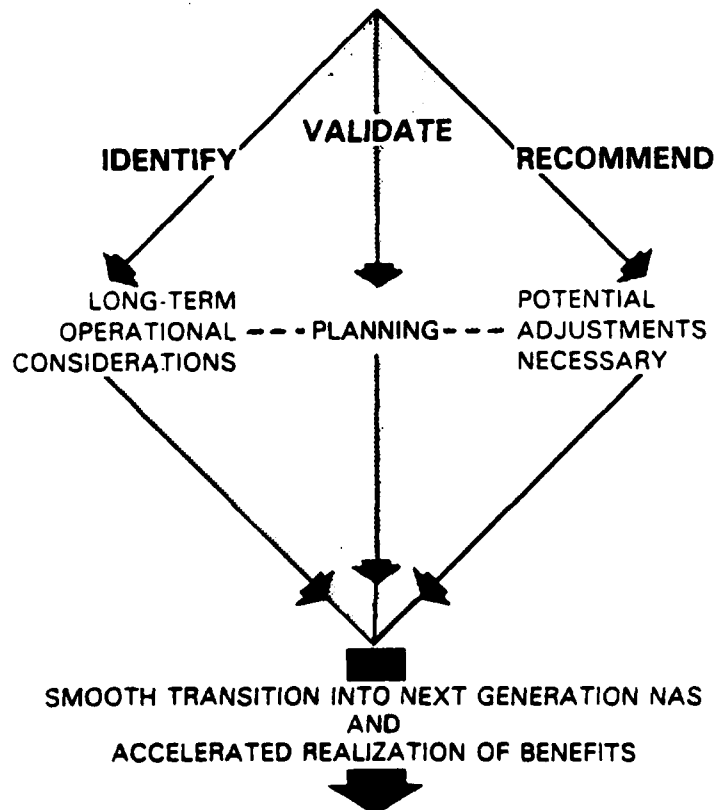
THERE IS A DIRECT RELATIONSHIP BETWEEN THE NAR ENHANCEMENT PLAN AND THE STATED INTENT OF THE NAS PLAN TO EFFECT SYSTEM IMPROVEMENTS.



MODERNIZATION



COOPERATIVE GOVERNMENT/INDUSTRY REVIEW  
AIRSPACE/PROCEDURAL/REGULATORY ASPECTS  
OF THE EVOLVING AND ENHANCED SYSTEM



SYSTEM MODERNIZATION IMPLEMENTATION

## PREFACE

The National Airspace Review (NAR) Enhancement Program is a cooperative government/industry effort to review airspace allocations and the procedural and regulatory aspects of scheduled improvements envisioned under the National Airspace System (NAS) Plan as well as other plans. Its purpose is to identify long-term operational considerations of enhanced systems as they evolve. Improved capabilities resulting from equipment already developed or in the process of development will be examined, with attention being focused on operational considerations rather than specific generation of system requirements. The program and its related studies will serve to identify, analyze, and document potential adjustments and current system validations to airspace, procedures, and regulations necessitated by system enhancements and related to increasing demands on airspace, changing user requirements, and fuel efficiency programs. Recommended changes will then be assessed as a basis for establishing operational adjustments or for integration into associated research and development efforts. Since determination of potential operational adjustments prior to equipment implementation will allow for effective utilization of the improved capabilities with an accelerated realization of benefits, the NAR Enhancement Program is one of FAA's key planning elements for the NAS modernization. The changes and validations which result will provide the operational framework for moving into the next generation National Airspace System.

The NAR Enhancement Program includes participation by representatives from the aviation industry, the Department of Defense (DOD), FAA, other Federal agencies, labor, and State aviation agencies. FAA believes that the recommendations related to each task assignment will represent a balance of views between users and the FAA because of the joint participation aspect of the plan.

Task Group 4-6.1 of the NAR Enhancement Program convened in Washington, D.C., from January 8 - 10, 1985, and January 29, 1985. This task group was responsible for reviewing and analyzing operational considerations based on the development of enhanced airport surface detection equipment. The recommendations contained herein will be submitted to the Administrator, Federal Aviation Administration, through the NAR Enhancement Executive Steering Committee (EXCOM), for consideration and disposition.

## **EXECUTIVE SUMMARY**

### **Task Group 4-6.1**

#### **Enhanced Airport Surface Detection Equipment**

Task Group 4-6.1 met from January 8-10, 1985 and again on January 29, 1985 to consider any potential adjustments to procedures necessary with the advent of enhanced airport surface detection equipment, ASDE-3. This meeting represented the overall mission of Task Group 4-6 to consider the operational aspects of airport surface detection equipment.

The present ASDE equipment is installed at 13 major airports. It has had a maintenance problem with tube failures, and the radar has not been useful in heavy rain due to backscatter from rain droplets, resulting in a "whiteout" and absorption of signals at its emitted frequency by the rain. ASDE-3, which will be installed at 29 major airports and at the FAA Academy, is a high resolution, ground mapping radar specified to be capable of providing ATC with a clear and accurate presentation of aircraft and vehicles on runways, taxiways, and aprons under all weather conditions, weather penetration information 95% of the time when visibility is less than one mile, an operational availability of .995 including scheduled maintenance, and the ability to resolve any combination of vehicles and aircraft separated by 80 feet or more with 12 foot positional accuracy and detect high speed (i.e., 165 knots) aircraft up to a height of 200 feet above ground level (AGL).

#### **Areas of Consideration**

To assist in its deliberations, Task Group 4-6.1 concentrated its review efforts in four major areas: procedures standardization, utilization standards, separation applications, and regulations. The task group developed and drafted nine recommendations, the more important of which identify procedural requirements for consideration based on implementation of the new system, separation standards development based on these procedural requirements, and a recommendation to operate the new system on a full-time basis. Other recommendations relate to system program implementation priority, the potential adoption of recommended procedural requirements to the present system, as well as the inclusion of system description and availability information in the AIM and other aviation publications.

#### **Validations**

In addition to formal recommendations, the task group validated that existing FAA training programs and the training development processes necessary to support new programs were adequate for the education of controllers in areas necessary to utilize the new system. Non-adopted findings and results related to potential helicopter system applications

were forwarded to the Rotorcraft/STOL Terminal Operations Task Group (TG 4-5.1) scheduled for June, 1985 for further consideration. Emphasis was also placed on a future system capability to track aircraft identification directly on the display and the interfaces that would need to be integrated, i.e., AAS, system alphanumerics, etc., to accomplish this objective. Agreement was reached that this concept should be forwarded to the FAA ASDE System Requirements Team (SRT) and the Airport Operators Council International, Inc. (AOCI) for further consideration.

### **Recommendations**

A complete set of the recommendations for Task Group 4-6.1 follows:

#### **RECOMMENDATION 4-6.1.1: ASDE-3 Procedural Requirements - General**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used anytime to:

1. Augment controller visual observation of aircraft and/or vehicular movements on the movement area.
2. Monitor compliance with control instruction by aircraft and vehicles on the taxiways and runways.
3. Confirm pilot reported positions.
4. Provide directional taxi information on pilot request.

#### **RECOMMENDATION 4-6.1.2: ASDE-3 Procedural Requirements - Prevailing Visibility Less Than One Mile**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used to determine that the active runways(s) are clear of aircraft and vehicles prior to a landing or departure when prevailing visibility is less than one mile.

#### **RECOMMENDATION 4-6.1.3: ASDE-3 Procedural Requirements - Category III Visibility Conditions**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used to control and separate identified aircraft from other known aircraft or ground vehicles on runways and taxiways when Category III weather conditions exist.

The Task Group notes that it remains the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller. In addition, ASDE-3 is not an operational requirement for Category III approaches.

NOTE: There was one dissenting opinion concerning the appended note. Comments and analysis can be found on pages 10-11.

**RECOMMENDATION 4-6.1.4: ASDE-3 System Operation**

Task Group 4-6.1 recommends that, when the ASDE-3 system is implemented, it be operated on a full-time basis.

**RECOMMENDATION 4-6.1.5: Taxiway Longitudinal Separation Standards**

Task Group 4-6.1 recommends that, based on Recommendation 4-6.1.3, the FAA develop longitudinal separation standards for aircraft on runways and taxiways when cockpit visual reference cannot be maintained.

**RECOMMENDATION 4-6.1.6: Procedural Requirements Application to ASDE-2**

Task Group 4-6.1 recommends that, where feasible, the FAA shall apply the provisions identified in Recommendations 4-6.1.1, 4-6.1.2, and 4-6.1.4 to the present ASDE system.

**RECOMMENDATION 4-6.1.7: ASDE-3 Implementation Priority**

Task Group 4-6.1 recommends that in consideration of the important contribution that ASDE can make to the enhancement of safety and efficiency in airport traffic control, that the current ASDE-3 implementation program be identified as a high priority FAA program and expedited as soon as possible.

NOTE: There was one dissenting opinion. Comments and analysis can be found on page 19.

**RECOMMENDATION 4-6.1.8: ASDE System Description in Airman's Information Manual (AIM)**

Task Group 4-6.1 recommends that a description of ASDE and how it is used in the NAS, including pilot prerogative to request taxi advisories, be included in the AIM.

**RECOMMENDATION 4-6.1.9: ASDE System Availability Information in Aviation Publications**

Task Group 4-6.1 recommends that the Airport/Facility Directory (A/FD), airport taxi diagrams, and other appropriate publications reflect the availability of ASDE.

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## **INTRODUCTION**

## INTRODUCTION

### Airport Surface Detection Equipment (ASDE)-3

The key factor necessary for airport surface traffic control is adequate surveillance capability from the control tower under all operating weather conditions. Airport surface detection equipment can provide the surveillance capability necessary under poor visibility conditions when the primary surveillance mode, i.e., visual observation, cannot be used.

#### Current Operational Environment

Airport surface traffic control is concerned with the movement of: arriving aircraft through the phases of final approach, landing, and taxiing to the terminal; departing aircraft through the phases of push back from the terminal, taxiing to the departure runway, takeoff, and initial climb; aircraft in transit between sites at the airport; and service or emergency vehicles, including snow plows or fire engines, operating on the movement area. The system manages the flow of vehicular movement within its jurisdiction based on four major objectives: to maximize safety and quality of service; to minimize aircraft delays and fuel use; to minimize air pollution and noise; and to minimize other costs incurred by airport operators, users, and participating local, state, and Federal government agencies.

Airport surface traffic control is provided from the control tower cab situated above the airport to provide good visual coverage of an airport's runway and taxiway network. In general, two controller positions are involved: ground controllers, who control the taxiway network, and local controllers, who are responsible for runway management, including landing clearances, takeoff clearances, and runway crossing clearances.

Visual surveillance is the primary method by which ground and local controllers acquire information on the position and identity of vehicles under their jurisdiction. The controllers rely on visual observation through the windows of the tower cabs as the primary means of surveillance. They also use radio position reports and airport surveillance radar (ASR) as added means of surveillance. ASR, which provides a radar-derived display of the positions and associated identities of airborne aircraft in the vicinity of an airport, is used to monitor aircraft on final approach or initial climb. In addition, the airport surface detection equipment currently available at thirteen airports provides ground and local controllers with a display of airport surface traffic activity.

Without ASDE, both ground and local controllers experience certain difficulties during low visibility conditions and must rely on pilot position reports via VHF radio. The principal problem encountered by local controllers is the loss of timing information associated with runway operations. In general, the distribution of arrival traffic is determined by the approach controller in the IFR room. The local controller must fit

the departure traffic released by the IFR room into the spacing opportunities afforded by the distribution of the arrival traffic. This is made more difficult where a single runway is being used for mixed arrival and departure traffic or where arrival and departure runways intersect. In the absence of ASDE, poor visibility conditions force local controllers to rely on imprecise pilot position reports which requires frequent use of radio frequencies. This results in a loss of approximately 25 percent of runway capacity for the single mixed runway case. The ASDE display, however, provides independent position and timing information on runway traffic and on arrival and departure aircraft up to an altitude of about 150 feet. With an ASDE, therefore, runway capacity in poor visibility can be restored to within approximately 5 percent of the good visibility capacity for the single mixed runway case. The lack of identity information on the ASDE display has less significance for the local controller since traffic is ordered and sequential, which allows for a ready correspondence between the ASDE position information and flight strip identity.

Information on position and identification is more critical than timing information for the ground controller. Of the approximately 50 percent loss in capacity experienced by ground control due to poor visibility, only about one third can be restored through the use of ASDE, the principal problem being the correlation of radar position information with vehicle identification. Unlike the local controller, the ground controller's traffic is not well-ordered, and significant VHF radio traffic is required during poor visibility conditions to maintain the position and identity correlation on the ASDE display. The VHF traffic tends to result in radio channel saturation which substantially reduces the ground controller's ability to move aircraft efficiently. Except for exceptional circumstances and individual situations at various airports, however, it is the local controller's management of runway capacity and not ground movement capacity which limits airport traffic-handling capability. Thus an ASDE-equipped ground controller can match the capacity of an ASDE-equipped local controller under poor visibility, despite the loss of the ground controller's capacity relative to good weather performance.

The ASDE-2 now being used at major airports has been operational for the past twenty years. Being a vacuum tube design, it has had a maintenance problem with tube failures, resulting in a mean time between failures (MTBF) rate of approximately 200 hours. In addition, the radar is nearly useless in heavy rain due to backscatter from rain droplets, which results in a "white-out" on the screen and absorption of signals at its emitted frequency by the rain. This has given rise to the frequent complaint that the ASDE-2 works best when it is not needed, and works worst when it is needed most.

Although implementation of improved airport surface detection equipment will provide a better approximation of the ground movement situation, it will not enable FAA to provide ground navigational guidance. Thus, it will remain the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller. Currently few low visibility operations are being conducted. In the United States, nineteen airlines have aircraft certified for Category II operations, eight

After further discussion it appeared that the group was beginning to agree that a 500 foot separation minimum was excessive. The DOD member questioned whether a lower separation minimum could be identified that would prevent aircraft collisions when visual separation cannot be affected. The FAA, noting such unknowns as actual system performance, suggested that ATC should merely ensure that targets not merge. Several members challenged this position. It was noted that what is eventually envisioned for these low visibility operations would be the identification of an RVR value at which point it would be mandatory for FAA to monitor aircraft, and a lower RVR value at which FAA would effect positive separation.

The group agreed that the issue and concerns that led to the current position, i.e., the alternatives of either providing a merging target separation standard, or assigning separation minima of between 150 and 500 feet to conduct such operations should be included in the analysis.

**RECOMMENDATION 4-6.1.5: Taxiway Longitudinal Separation Standards**

Task Group 4-6.1 recommends that, based on Recommendation 4-6.1.3, the FAA develop longitudinal separation standards for aircraft on runways and taxiways when cockpit visual reference cannot be maintained.

study described as the condition at which pilots begin to lose the ability to visually sight other aircraft. The target figure of 500 feet would need confirmation by testing and analysis.

Questions were raised, however, about the types of aircraft and vehicles to which the minima would apply. Experiences with handling aircraft in such visibility conditions at O'Hare and Kennedy Airports were described. Notwithstanding the low number of Category III A or B operations currently being conducted, a suggestion was made that many more low visibility operations will be taking place in the future. In the United States, there are currently nineteen airlines with aircraft types certified for Category II operations, eight airlines with aircraft certified for Category III A operations, and five airlines with aircraft certified for Category III B operations. Although continued increases in these operations are anticipated, tighter requirements for operations below 600 feet RVR may be established, i.e., taxiway centerline lighting, signage, sterile taxiway procedures, etc. The RVR values currently associated with Category III operations were identified: Category III C, less than 150 feet RVR; Category III B, between 150 feet and 700 feet RVR; and Category III A, between 700 feet and 1,200 feet RVR.

In response to a suggestion that advisories should be provided in lieu of establishing separation minima based on ASDE-3 utilization, the ALPA member, noting system capabilities as well as the FAA's comments, suggested that pilots will certainly use improved visual cues, i.e., lighting, signage, etc.; however, in low visibility conditions, where pilots can no longer affect visual separation, ATC should control and separate aircraft. Several members questioned whether 500 feet would be excessive for certain types of aircraft and ground vehicles in those visibility conditions. FAA reiterated that due to the idiosyncrosies of individual airports, i.e., blind spots, ability to maintain aircraft vehicles on taxiway centerlines, etc., certification teams may be required to visit each airport before an ASDE-3 system can be used for separation purposes. The FAA member also believed that members should not correlate ASDE-3 with radar since it is a digitized, artificial display, which, when implemented may not display in infinite detail all segments and areas of the airport ground movement system. Based on the discussion, a suggestion was made by the FAA that it form a working group composed of representatives from the Office of Flight Operations (AFO), Air Traffic Operations Service (ATO), and the Program Engineering and Maintenance Service (APM) to resolve the separation issue and other aspects of low visibility operations.

Discussion concerning a 500 foot separation minimum continued. It was noted, for example, that although a Part 91 operator can legally taxi and depart in zero-zero weather minimums and may be able to see an aircraft 100 or 200 feet ahead, the same pilot may be unable to see an aircraft 500 feet ahead. Members were concerned that setting minimums that are too large may be counterproductive in that they might increase delays and adversely affect capacity under such conditions. Other members noted that the controller-provided 500 foot separation minimum could be waived by pilots who notify ATC that they can see and follow another aircraft.

#### Recommendation 4-6.1.5: Taxiway Longitudinal Separation Standards

##### FACTS/ASSUMPTIONS

Recommendation 4-6.1.3 states that when ASDE-3 is commissioned, it shall be used to control and separate identified aircraft from other known aircraft or ground vehicles on runways and taxiways when Category III weather conditions exist. The ability to control and separate aircraft from other aircraft or vehicles presupposes that longitudinal separation minima have been established for the operations on ground movement areas.

##### ANALYSIS

Based on the ASDE-3 system's enhanced capabilities, i.e., all-weather operation, availability of .995 including scheduled maintenance, and high resolution capability (e.g., able to identify any combination of vehicles and aircraft separated by 80 feet or more with 12 foot positional accuracy), the group examined the system procedural requirements identified in Recommendation 4-6.1.3, which states that, when commissioned, the system shall be used to control and separate identified aircraft from other known aircraft or ground vehicles on runways and taxiways when Category III weather conditions exist. In poor visibility conditions, pilots currently request assistance for taxiing; under the new procedure, however, ATC would actually be separating aircraft based on system-derived information, although pilots would remain responsible for navigation and would retain the option to take visual spacing (separation) in order to follow other aircraft. Separating aircraft based on system-derived information presupposes that separation standards and minima are developed for such operations.

The problems inherent to the development of such standards were examined during the task group session: actual system performance capability remains unknown; other variables that would effect standards development would include the aircraft types involved with such operations, braking action capabilities of various aircraft, and the frequency of such operations. A recommendation did result, however: based on Recommendation 4-6.1.3, the group believed the FAA should develop longitudinal separation standards for aircraft on runways and taxiways when cockpit visual reference cannot be maintained.

The group reconvened on January 29, 1985 to determine whether minima could be identified to separate aircraft on taxiways when poor weather conditions exist; i.e., cockpit visual reference cannot be maintained. The DOD member, based on discussion with military pilots and ATC, suggested that a separation standard of 500 feet might be appropriate where ATC is solely in charge of separating aircraft on taxiways. He noted that the ICAO Draft Surface Movement Guidance and Control Study (Section 6.8.1, p. 48) states that "departure demand for high transport traffic... does not show much visibility sensitivity until runway visual range (RVR) decreases below 200 meters (approximately 650 feet)", which the ICAO

operational availability of the system will be at least .995, including all downtime and scheduled maintenance.

Since the ASDE-3 will operate accurately and efficiently under all weather conditions and due to the vast improvements in system reliability, maintainability, and availability over the present system, the group believed that, once installed, the system should be operated on a full-time basis. A recommendation was therefore drafted for that purpose.

**RECOMMENDATION 4-6.1.4: ASDE-3 System Operation**

Task Group 4-6.1 recommends that, when the ASDE-3 system is implemented, it be operated on a full-time basis.

#### **Recommendation 4-6.1.4: ASDE-3 System Operation**

##### **FACTS/ASSUMPTIONS**

The ASDE-2 system has been operational at major airports for over twenty years. Due to maintenance and resolution problems, it is not operated on a full-time basis.

##### **ANALYSIS**

The ASDE-2 system being utilized at major airports has now been operational for over twenty years. Being a vacuum tube design, it has had a maintenance problem with tube failures, with a mean time between failures (MTBF) rate of approximately 200 hours. In addition, the radar is nearly useless in heavy rain due to backscatter from rain droplets, which results in a "whiteout" and the absorption of signals at its emitted frequency by the rain. This has given rise to a persistent criticism of the system that it works best when it is not needed by ATC, and does not work adequately when its utilization would be most beneficial (i.e., under reduced visibility conditions).

Due to these maintenance and resolution problems, ASDE-2 is not operated on a full-time basis at the airports where it is currently installed. Examples of the conditions under which it is utilized at Chicago's O'Hare and New York's Kennedy Airports were provided during the session, i.e., from dusk to dawn, under deteriorating visibility conditions only, etc.

Unlike the ASDE-2, the ASDE-3 system will be a solid state design, high resolution, ground mapping radar that will provide ATC with a clear, accurate, and bright presentation of aircraft and vehicles on runways and taxiways. The system will operate efficiently under all weather conditions, and will provide weather penetration information 95% of the time when visibility is less than one mile.

The Department of Transportation, Federal Aviation Administration Preliminary Draft Specification for Airport Surface Detection Equipment ASDE-3, dated April 12, 1984 identifies the expected reliability and maintainability of the system (see Appendix B). The radar will have a predicted MTBF greater than 2,000 hours based on system relevant failures, which are defined as failures within the system that degrade radar performance. The mean time between corrective maintenance (MTBCM), based on relevant failures, will be greater than 620 hours for the local installation and 550 hours for the remote installation. The mean time to repair (MTTR) should approximate 30 minutes, with a maximum corrective maintenance time of one and a half hours. Preventive maintenance of the entire radar system should not be required more often than once a month. Corrective and preventive maintenance should not exceed 5 hours in one year of operation (8,760 hours) for either the local tower or the remote installation and includes only the time required for corrective diagnosis, repair, realignment, and proper reinitiation of system operation. Thus,

The Task Group notes that it remains the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller. In addition, ASDE-3 is not an operational requirement for Category III approaches.

reinforce that Category III approaches may be performed at locations without ASDE systems.

\* \* \* \*

The Air Line Pilots Association (ALPA) submitted the following comment with respect to Recommendation 4-6.1.3:

ALPA fully supports the recommendation but does not support the categorical statement in the note which states that "ASDE-3 is not an operational requirement for Category III approaches." Requirements for Category III operations was not one of the group's areas of consideration. There is no technical supporting data in the report to support such a statement. To the contrary, the report states on page 10 that "the presence of an ASDE might become a future operational requirement."

\* \* \* \*

**RECOMMENDATION 4-6.1.1: ASDE-3 Procedural Requirements - General**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used anytime to:

1. Augment controller visual observation of aircraft and/or vehicular movements on the movement area.
2. Monitor compliance with control instruction by aircraft and vehicles on the taxiways and runways.
3. Confirm pilot reported positions.
4. Provide directional taxi information on pilot request.

**RECOMMENDATION 4-6.1.2: ASDE-3 Procedural Requirements - Prevailing Visibility Less Than One Mile**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used to determine that the active runways are clear of aircraft and vehicles prior to a landing or departure when prevailing visibility is less than one mile.

**RECOMMENDATION 4-6.1.3: ASDE-3 Procedural Requirements - Category III Visibility Conditions**

Task Group 4-6.1 recommends that when ASDE-3 is commissioned, it shall be used to control and separate identified aircraft from other known aircraft or ground vehicles on runways and taxiways when Category III weather conditions exist.

ASDE-3 operational application. In excellent weather, where visibility is good, pilots are responsible for navigating within the ground movement area, although ATC provides guidance upon request and monitors aircraft movements. In this situation, ASDE-3 can be used by ATC when there are blind spots in the movement area or to augment visual observation if it can be of assistance to the controller. In situations of diminished visibility (i.e., less than one mile), where pilots can still maneuver because of good ground movement area visual guidance (i.e., lighting, signage, etc.), but tower visibility is reduced, controllers should rely on ASDE-3 to monitor aircraft movements and to ensure that active runways are clear of aircraft and vehicles prior to a landing or departure. Under very low visibility conditions (i.e., Category III), where the pilot's ability to navigate and separate own aircraft from other aircraft or vehicles is greatly restricted, ASDE-derived positive separation between aircraft and other aircraft or vehicles on runways, taxiways, and aprons should be provided.

Since the ASDE-3 system will be a high resolution, ground mapping radar capable of providing ATC with a clear and accurate presentation of aircraft and vehicles on runways, taxiways, and aprons under all weather conditions, weather penetration information 95% of the time when visibility is less than one mile, and have an operational availability of .995, the group believed that its utilization should be made mandatory under the conditions described in the latter two generalized weather situations, and remain optional as a supplementary tool under good visibility conditions. Three recommendations were drafted to identify how the system should be utilized under specific visibility conditions.

Although the ASDE-3 will provide a better approximation of the ground movement situation, it will not enable FAA to provide absolute ground navigational guidance, which means that it will remain the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller. Currently, few low visibility operations are being conducted in the United States. Nineteen airlines have aircraft certified for Category II operations, eight airlines have aircraft certified for Category III A operations, and five airlines have aircraft certified for Category III B operations (the runway visual range (RVR) values associated with Category III operations are as follows: Category III A, between 700 feet and 1,200 feet RVR; Category III B, between 150 feet and 700 feet RVR; and Category III C, less than 150 feet RVR). Although more and more low visibility operations are anticipated for the near future, tighter requirements for operations below 600 feet RVR may be established, i.e., taxiway-centerline lighting, signage, sterile taxiway procedures, etc., in addition to which the presence of an ASDE might become a future operational requirement. In the mean time, however, the group agreed that the third recommendation should be qualified. There was consensus that the Paragraph 3-71.B note appearing in FAAH 7110.65D should be added to the recommendation to emphasize to the user community that it remains the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller. A statement to indicate that the ASDE-3 system is not currently in and of itself an operational requirement for Category III approaches was also appended to

## RECOMMENDATIONS

- Recommendation 4-6.1.1: ASDE-3 Procedural Requirements - General
- Recommendation 4-6.1.2: ASDE-3 Procedural Requirements - Prevailing Visibility Less Than One Mile
- Recommendation 4-6.1.3: ASDE-3 Procedural Requirements - Category III Visibility Conditions

## FACTS/ASSUMPTIONS

ASDE-3 is a far more sophisticated airport surface detection equipment system than the system in current use at major airports, the ASDE-2, which has not operated well under all weather conditions and whose performance has been characterized by maintenance and reliability problems. Requirements for the new system include that it be useable in all weather conditions, have an operational availability of .995 including scheduled maintenance, and be capable of resolving any combination of vehicles and/or aircraft separated by 80 feet or more with 12 foot positional accuracy and detecting high speed (i.e., 165 knots) aircraft up to a height of 200 feet above ground level (AGL). Based on the premise that these system enhancements will occur, procedural adjustments should be made so that the system will be of greatest benefit to both ATC and the user community.

## ANALYSIS

Based on a review of current procedures and an assessment of ASDE-3 system specifications, airport surface detection procedural modifications were recommended by Task Group 4-6.1.

Section 6 of Chapter 3, Air Traffic Control-Terminal, of the Air Traffic Controller's Handbook, FAAH 7110.65D, dated October 25, 1984, describes the provisions governing airport surface detection equipment usage. ASDE is currently used to augment visual observation of aircraft and vehicular movements on runways and taxiways when visibility is less than the most distant point in the active movement area, and when, in the controller's judgment, its use will assist at any time in the performance of duties. In addition, ASDE-derived information is used to determine that a runway is clear of aircraft and vehicles prior to a landing or departure, to monitor compliance with control instructions by aircraft and vehicles on the taxiways and runways, to confirm pilot reported positions, and to provide directional taxi information on pilot request.

In order to identify the procedural adjustments that would be necessary due to the enhanced capabilities of the equipment (i.e., all-weather operation and availability, high resolution capability, etc.), three generalized weather situations were examined initially for potential

## VALIDATION

### FAA Training Program and Training Program Development Processes

Controllers will be the essential element for the safe and efficient operation of the ASDE-3 system. If expanded utilization of the ASDE-3 system is to be achieved in the near to mid-term, controllers will need to be well-versed in all responsibilities placed upon them in order to provide the necessary services to the user community.

Concerns were raised during the task group session about the availability and adequacy of existing training programs for the purpose of educating controllers in areas related to recommended procedural requirements. Several training programs offered by the FAA Academy in Oklahoma City that could serve to educate controllers in some areas suggested by the new procedural requirements were described. In addition, there was general agreement that existing FAA training program development processes were adequate for any future training program development that might be required to train controllers in the usage of the ASDE-3 system.

**DISCUSSION OF MEETING RESULTS**

#### 4. Regulations

- a. Can and should vehicles be included in regulations pertaining to operating on airport movement areas?

Some of the reference materials used by the task group have been included as appendices in order to facilitate a review of the material contained in this staff study.

### Anticipated Benefits

Potential benefits from the proposed implementation of ASDE-3 should primarily accrue during adverse weather conditions. With ASDE-3, more and more low visibility operations can be conducted in an enhanced safety environment. Airport capacity increases should result, with greater potential for revenue from passenger enplanements. Reductions in delays should also result in fuel and other cost savings to the aviation community.

### Areas of Consideration

As a guide to its deliberations, Task Group 4-6.1 used the following areas of consideration:

1. Procedures Standardization
  - a. What differences exist in ASDE utilization where systems are currently located and why?
  - b. How can any noted differences in procedures be standardized for current ASDE locations?
2. Utilization Standards
  - a. What potential utilization of current ASDE systems has not been realized because of procedural constraints and can these constraints be mitigated?
  - b. What utilization standards need to be developed for enhanced ASDE (ASDE-3) systems?
3. Separation Applications
  - a. What separation applications might result from ASDE-3 all-weather surveillance and other unique capabilities?
  - b. What separation applications might result from ASDE-3 higher target resolution?
  - c. Do unique ASDE-3 capabilities support its utilization for rotorcraft/STOL operations under Instrument Meteorological Conditions (IMC)?
  - d. How can ASDE-3 capabilities be utilized for Visual Meteorological Conditions (VMC) separation applications where control tower visibility of movement areas is obscured?

airlines have aircraft certified for Category III A operations, and five airlines have aircraft certified for Category III B operations (the runway visual range (RVR) values associated with Category III operations are as follows: Category III A, between 700 feet and 1,200 feet RVR; Category III B, between 150 feet and 700 feet RVR; and Category III C, less than 150 feet RVR). Although more and more low visibility operations are anticipated for the future, tighter requirements for operations below 600 feet RVR may be established, i.e., taxiway centerline lighting, signage, sterile taxiway procedures, etc., in addition to which the presence of an ASDE might become an operational requirement in the future.

### **System Description**

Due to the ASDE-2's unsatisfactory performance in certain weather conditions, its maintenance problems, and other system deficiencies, the FAA undertook a development program to design new airport surface detection equipment.

The new ASDE-3 system will be a solid state design, high resolution, ground mapping radar that will provide ATC with a clear, accurate, and bright presentation of aircraft and vehicles on runways and taxiways. The system will operate efficiently under all weather conditions and will provide weather penetration information 95% of the time when visibility is less than one mile. The system will have an operational availability of .995, including scheduled maintenance, and will be capable of resolving any combination of vehicles and/or aircraft separated by 80 feet or more, with 12 foot positional accuracy, as well as detecting high speed (i.e., 165 knots) aircraft up to a height of 200 feet above ground level (AGL). Thirty airports will have ASDE-3 systems delivered during the fiscal year (FY) 1988 - 1990 time frame.

### **Relation to NAS Modernization**

There is a direct functional relationship between TG 4-6.1 and the NAS Plan Project entitled "Airport Surface Detection Equipment (ASDE)-3." Implementation of the ASDE-3 equipment, which is planned in the FY 1988 - 1990 time frame, is expected to generate some adjustments to procedures and regulations applicable to operations on airport surface movement areas.

### **Anticipated Operational Considerations**

Potential adjustments and modifications in the areas of procedures standardization, usage requirements, and regulations relating to operating in airport surface movement areas are anticipated. Additional standards for separation applications during visual and instrument meteorological conditions (VMC/IMC) and for rotorcraft/STOL operations may be developed.

#### **Recommendation 4-6.1.6: Procedural Requirements Application to ASDE-2**

##### **FACTS/ASSUMPTIONS**

ASDE-2 system performance has been characterized by resolution and maintenance problems. System utilization is not optimum where it is currently installed.

##### **ANALYSIS**

The ASDE-2 system is currently being utilized to augment pilot reports or visual observation for landings, departures, and, to a certain extent, ground movement on taxiways. System performance has not been satisfactory, however. It has had a maintenance problem with tube failures, and the radar is not useful in heavy rain due to backscatter from rain droplets, which results in a "whiteout" and the absorption of signals at its emitted frequency by the rain.

Nevertheless, the membership agreed that its use can restore some of the capacity currently lost in low visibility conditions. In addition, provision of any services by the system is predicated on its optimal operation.

Because of the potential capacity improvements and safety enhancements that could be generated through more optimal use of the current system, the group initially believed that the provisions of Recommendations 4-6.1.1, 4-6.1.2, 4-6.1.3, and 4-6.1.4 should be adopted for the current system, namely, that the conditions under which it is used as a supplementary tool versus a mandatory tool should be specified and that the system should be operated on a full-time basis. There was concern, however, about Recommendation 4-6.1.3, which states that the system shall be used to control and separate identified aircraft from other known aircraft and/or ground vehicles on runways and taxiways when Category III weather conditions exist. The FAA reiterated that there is no capacity within the present system to provide the type of control and separation that members are expecting. The group, therefore, deleted the provision of Recommendation 4-6.1.3 from this recommendation.

#### **RECOMMENDATION 4-6.1.6: Procedural Requirements Application to ASDE-2**

Task Group 4-6.1 recommends that, where feasible, the FAA shall apply the provisions identified in Recommendations 4-6.1.1, 4-6.1.2, and 4-6.1.4 to the present ASDE system.

#### Recommendation 4-6.1.7: ASDE-3 Implementation Priority

##### FACTS/ASSUMPTIONS

The current ASDE-3 specification was finalized in December 1984, at which time a request for proposal (RFP) was issued for the system's production. A contract is expected to be awarded in late fiscal year (FY) 1985. Preliminary and critical system design reviews will take place in FY 1987. First delivery of the system is anticipated in FY 1988, while final delivery is scheduled for FY 1990. Program funding for 12 replacement systems and 5 new systems will be allocated in the FY 1985 budget, and for 12 new and 1 replacement system in the FY 1986 budget.

##### ANALYSIS

During the session, lengthy discussion outlining the user community's dissatisfaction with current system performance took place. Based on the expected benefits to be derived by implementation of ASDE-3, tentative support was initially given to recommending earlier implementation of the new system in order to provide a more immediate solution for increasing safety and efficiency in terminal operations under conditions of reduced visibility. Notwithstanding this sentiment, the DOD member suggested that any schedule changes for ASDE-3 implementation would have to be weighed carefully against the requirements of other system programs provided for in the National Airspace System Plan (Brown Book). In addition, the program managers for the new system had indicated that the existing production and delivery schedules are already optimistic for a production line item.

Citing the schedule degradation that faces other equipment systems and the user community's growing impatience with the progress being made under the modernization program, several members believed that a recommendation should be made which places greater emphasis on the need to adhere to the system's implementation schedule. The group recommended, therefore, that because the ASDE-3 system will be superior in terms of performance and reliability, and will thereby contribute to capacity improvements and enhanced safety, it should be recognized as a high priority program and expedited as soon as possible.

\* \* \* \*

The DOD member dissented on Recommendation 4-6.1.7, noting that he could not agree that the current ASDE-3 system implementation should be identified as a high priority program, since the program managers had indicated that it was being implemented as fast as possible. He also believed that placing more program and budgeting priority on the ASDE could have a detrimental impact on other programs that might provide greater, more immediately realizable benefits. Finally, he noted that unless recommended procedural applications are implemented along with system deployment, little capacity improvement could be expected.

\* \* \* \*

**RECOMMENDATION 4-6.1.7: ASDE-3 Implementation Priority**

Task Group 4-6.1 recommends that in consideration of the important contribution that ASDE can make to the enhancement of safety and efficiency in airport traffic control, that the current ASDE-3 implementation program be identified as a high priority FAA program and expedited as soon as possible.

**Recommendation 4-6.1.8: ASDE System Description In Airman's Information Manual (AIM)**

**Recommendation 4-6.1.9: ASDE System Availability Information In Aviation Publications**

#### **FACTS/ASSUMPTIONS**

The Airman's Information Manual (AIM) dated October 25, 1984 contains a Pilot/Controller Glossary definition of airport surface detection equipment. Other FAA publications/periodicals, including the Airport/Facility Directory (A/FD) and Instrument Approach Procedures (IAPs) do not reflect the system's availability at individual airports.

#### **ANALYSIS OF FACT**

The current edition of the AIM contains the following definition for airport surface detection equipment in the Pilot/Controller Glossary:

Airport Surface Detection Equipment/ASDE - Radar equipment specifically designed to detect all principal features on the surface of an airport including aircraft and vehicular traffic and to present the entire image on a radar indicator console in the control tower. Used to augment visual observation by tower personnel of aircraft and/or vehicular movements on runways and taxiways.

During its review, pilot unfamiliarity with airport surface detection equipment and its availability at individual airports was discussed by the membership. Based on the fact that the information derived from the system can be utilized, in particular, to provide directional taxi information, the group believed that additional information should be included in the AIM to describe the system, to indicate how it is used by ATC, and to alert pilots to their prerogative to request directional taxi advisory information. Furthermore, the group agreed that in order to utilize the equipment, information concerning its availability at individual airports should be included in other FAA publications, including the Airport/Facility Directory (A/FD) and Instrument Approach Procedures (IAPs).

#### **RECOMMENDATION 4-6.1.8: ASDE System Description In Airman's Information Manual (AIM)**

Task Group 4-6.1 recommends that a description of ASDE and how it is used in the NAS, including pilot prerogative to request taxi advisories, be included in the AIM.

**RECOMMENDATION 4-6.1.9: ASDE System Availability Information in Aviation Publications**

Task Group 4-6.1 recommends that the Airport/Facility Directory (A/FD), airport taxi diagrams, and other appropriate publications reflect the availability of ASDE.

## **NON-ADOPTED FINDINGS AND RESULTS**

### **ASDE-3 System Applications To Helicopter Operations**

During the session, concepts discussed included the potential application of the system to helicopter operations, specifically departures and arrivals under Instrument Flight Rule (IFR) or Special Visual Flight Rule (SVFR) conditions, and whether ASDE-3 could be utilized to affect longitudinal separation in helicopter air taxi operations. Although it was suggested that the system had not been designed with the intention of controlling and separating aircraft in three dimensions, i.e., hovering aircraft to and from landing and departure areas, it was not determined that the system could not be used for such an application. Improved helicopter surface and above ground movement may result from the combined implementation of ASR-9 radar and Mode S equipment. A suggestion was made that the potential application to use the system to monitor and separate helicopters taxiing to and from landing and departure areas above the surface of an airport should be forwarded to the Rotorcraft/STOL Terminal Operations Task Group scheduled for June 1985 for further amplification and consideration.

### **ASDE-4 Follow-on Enhancements**

Future enhancements to the system which the membership believed would be of major benefit to ATC and the user community were also identified. Emphasis was placed on a future ASDE system capability to track aircraft identification directly on the display, as well as the interfaces that would need to be integrated, i.e., AAS, system alphanumerics, etc., to accomplish this objective. There was general agreement that this suggested enhancement as well as another to expand the number of locations where ASDE is installed should be forwarded to the FAA's System Requirements Team (SRT) and the Airport Operators Council International, Inc. (AOC1) for further consideration.

**APPENDIX A:**

**TASK GROUP MEMBERSHIP**

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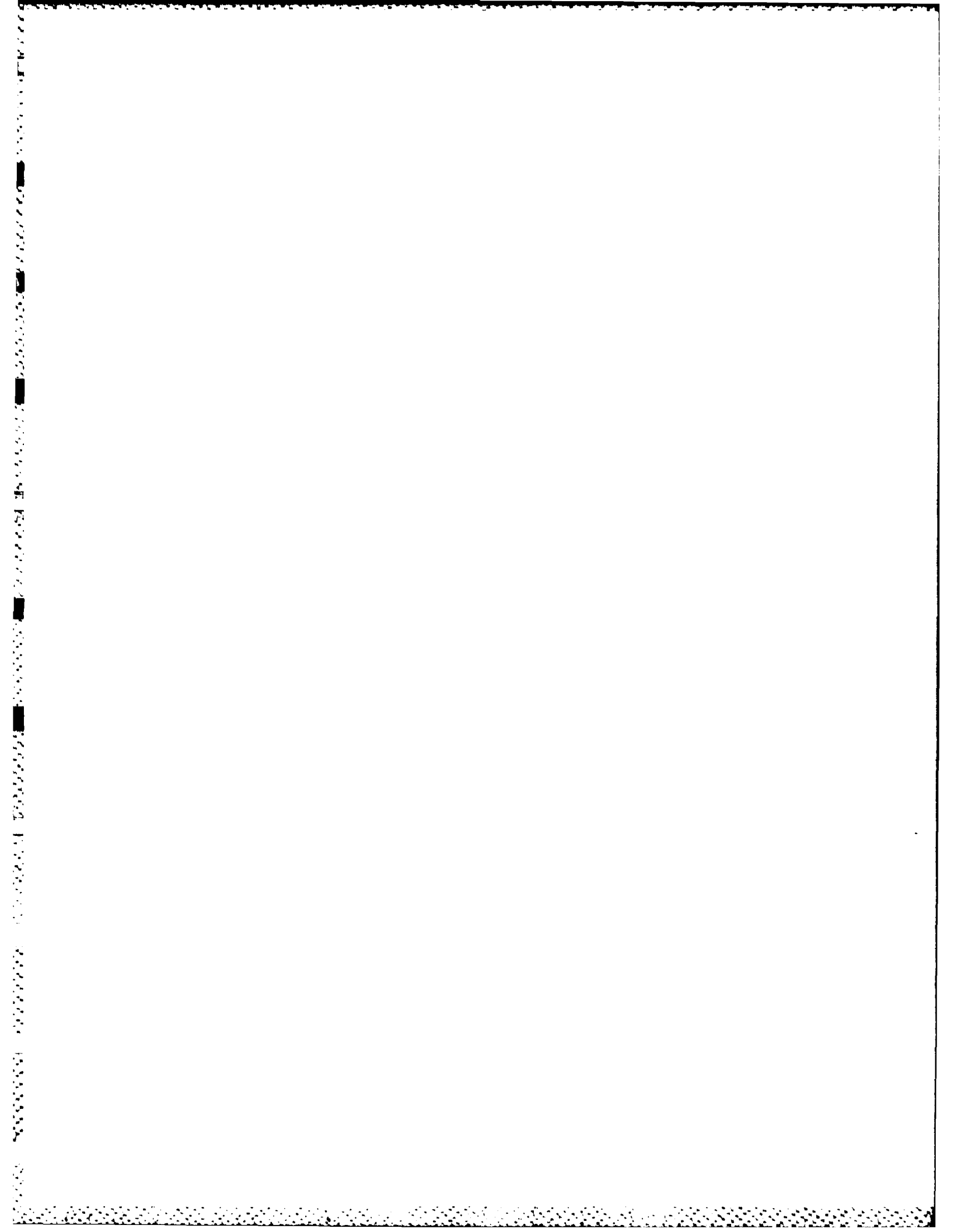
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**APPENDIX B:**

**PRELIMINARY DRAFT SPECIFICATION  
AIRPORT SURFACE DETECTION EQUIPMENT ASDE-3  
FAA-E-2725A, APRIL 12, 1984, P. 72-74**

PRELIMINARY DRAFT

SPECIFICATION

AIRPORT SURFACE DETECTION EQUIPMENT ASDE-3

1. SCOPE.- This equipment specified herein is an Airport Surface Detection Equipment (ASDE) System. This system provides high resolution, short-range, clutter-free, surveillance information on aircraft and vehicles, both moving and fixed, located on or near the surface of airport movement and holding areas under all weather and visibility conditions. Information generated by this system will be digitally converted from rho-theta to rectilinear and transmitted over television type communication circuits to bright displays at local and ground controller positions located in the airport control tower.

2. APPLICABLE DOCUMENTS.-

2.1 FAA Specifications.- The following FAA specifications of the issues specified in the invitation for bids or request for proposals form a part of this specification:

FAA-D-2494	Instruction Book, Manuscripts, Technical, Equipment and
Part 1	System Requirements, Preparation of Manuscripts

3.20 Reliability.- The ASDE ATCT or local tower cab (standard) configuration shall meet the Mean Time Between Failure (MTBF) and the Mean Time Between Corrective Maintenance (MTBCM) specified in the following paragraphs. The contractor shall submit predictions of MTBF and MTBCM using the techniques of MIL-STD-785B. Predictions shall be provided for each system configuration and for each major system element. These predictions shall be related to the reliability test plan. The contractor shall establish and implement a closed loop procedure to: (1) collect data on failures occurring during all phases of his effort including in-coming part inspections, production screening or burn-in tests and reliability acceptance tests; (2) statistically analyze the data to identify reliability problems and to assess the progress made in meeting reliability requirements; (3) perform engineering analyses of failed parts to ascertain the causes of the failures; (4) implement appropriate corrective action to preclude the recurrence of failure experienced; and (5) perform follow-on audits as necessary to assure adequacy of corrective action. All data shall be available for FAA inspection.

When major components of the system become available, the contractor will implement a failure data collection system. The data collection system shall comply with the Task 104 to 104.3.1.b and 104.3.1.c of MIL-STD-785B.

Production screening and/or burn-in tests shall be performed on critical boards, modules and assemblies to detect and reject reliability defects.

3.20.1 MTBF.- The ASDE-3 radar shall have a predicted MTBF, as defined in MIL-STD-781 based on system relevant failures, greater than 2,000 hours.

System relevant failures are defined as failures within the radar system that degrade the radar performance below those characteristics specified in 3.4. A failure in a redundant element shall not be classified as a system relevant failure if: (1) degradation occurs in the redundant element not is us; or (2) the redundant element is successfully switched on-line to replace the failed element within 1-minute of the occurrence of the malfunction, and the resulting operation meets the specified radar system performance level.

3.20.2 MTBCM.- The ASDE ATCT or local tower cab (standard) configuration shall have a predicted Mean Time Between Corrective Maintenance (MTBCM), based on relevant failures, greater than 620 hours for the local installation and greater than 550 hours for the remote installation. A relevant failure is any failure in the equipment supplied by the contractor that results in requiring maintenance action, not including (a) preventative maintenance action; (b) failures due to improper use of equipment or accidental damage; (c) failures in equipment used beyond the contractor recommended and government agreed upon change out times; (d) failures caused by external conditions beyond the conditions required by this specification; (e) secondary failures of parts caused by a primary failure that are not covered by conditions required by this specification; and (f) blown fuses where operation may be restored by replacement of the fuse, unless two or more failures occur in the same fuse within 5 hours.

#### **IV POTENTIAL OPERATIONAL CONSIDERATIONS**

Adjustments are anticipated in the area of procedures standardization and in regulations for operating on airport movement areas. Additional utilization standards may be developed for separation applications during visual meteorological conditions (VMC) and rotorcraft/STOL operations.

#### **V INTERRELATIONSHIPS**

##### **A. FUNCTIONAL**

The Airport Surface Detection Equipment study area (4-6) will provide information of interest to the Terminal Services (6-1) and Rotorcraft/STOL Operations Terminal (4-5) study areas. In its functional review of terminal services, 6-1 should consider any recommendations resulting from 4-6 that identifies a need for additional utilization standards for enhanced airport surface detection equipment. Likewise, 4-5 should review the findings of 4-6 regarding enhanced airport surface detection equipment utilization for rotorcraft/STOL operations. There is a direct functional relationship between 4-6 and the NAS Plan project "Airport Surface Detection Equipment (ASDE)-3". Implementation of this project is expected to generate some adjustments in the procedures and regulations applicable to operations on airport surface movement areas.

##### **B. TIME**

Currently, no follow-on studies are planned in the area of airport surface detection equipment.

**APPENDIX D:**

**TASK GROUP 4-6.1 ENHANCED AIRPORT  
SURFACE DETECTION EQUIPMENT ADVANCE  
INFORMATION PACKAGE, SECTIONS IV AND V,  
POTENTIAL OPERATIONAL CONSIDERATIONS AND  
INTERRELATIONSHIPS, P. 18-19**

d. Pulse-to-Pulse Frequency Agility

The actual ASDE-3 environment, although imprecisely known, was assumed to be at least 90 percent probability of detection and a  $10^{-6}$  probability of false alarm for a non-fluctuating target. To characterize ASDE-3 by a single pulse performance does not permit adequate imaging capabilities for vehicles and aircraft on airport surfaces under severe weather conditions. To account for precipitation backscatter and alternative climatological events to be recorded on airport surfaces, ASDE-3 incorporates multiple-target return pulses. This increased ASDE-3 capability was essential since rainfall decorrelation time is recorded in milliseconds while present ASDE 2 recording capacity remained in the approximately 50 to 70 microseconds interpulse period. Consequently, ASDE-3's frequency-agile system is superior in detection performance over existing single-frequency systems.

Second, the rotodome design provides maximum packaging efficiency. Its weight and size would be properly matched to its drive horsepower and antenna stiffness requirements.

b. Antenna Variable Focus

Variation in antenna aperture size from 24-GHz in ASDE 2 to 16-GHz in ASDE-3 reduces by three times the comparative ASDE-3 antenna size to the existing ASDE 2 system. However, at near target range distances of less than one nautical mile, for equal size antenna, clutter cell increases due to azimuth and elevation beam-broadening results. In addition, the 16-GHz ASDE-3 will accommodate nearby a 100-foot separation between the antenna and the electronics unlike the present 30-foot separation of ASDE 2.

The ASDE-3 system is capable of an overall azimuth resolution of 40 feet for targets at 6000 feet in range. This azimuth resolution capability will prevent smearing of extended targets. Also, this capability resolves small point targets on the airport surface.

The shape of the rotodome provides sufficient radar curvature near its reflector edges. The rotodome, a modified ellipsoid, is optimally capable of reducing aerodynamic drag and overturning moment. Further, with the rotodome, more care is possible in the control of the radio frequency window. That is, the radio frequency window will maintain a constant relationship to the antenna's rotation. Because of its radio frequency window performance, the rotodome's rain-shedding capability is optimized. A highly attenuating thin film of water over the radio frequency window is prevented from forming due to the centrifugal force field of the rotodome.

c. Cosecant (CSC) Elevation Beam-Shaping

The ASDE-3 system would be equipped with an approximate 5-foot vertical aperture capable of a 1.6 degree elevation beam width which provides for its up to 3 mile performance capability. Radar designers note that elevation beamshape choice presents a tradeoff between peak gain on elevation boresight, which affects target returns at maximum range, and gains at high-depression angles, which correspond to targets at close range. With ASDE-3's beamshape elevation, the system is capable of accommodating a minimum range of 500 feet for the tallest air traffic control tower.

ard dimensions of control tower roofs, the ASDE-3 antenna should not exceed 18 feet in horizontal extent. An antenna of this size lends itself to centralized roof top installation at control towers.

e. Antenna-Siting

Given the roof top control tower siting limitations by size, weight, structure or space, there will be cases where placement of ASDE-3 shall be separate from the control tower. If ASDE-3 will be a remote tower site, an 8000 feet remoting distance from the control tower is necessary.

f. Radar-Coverage

The candidate airports must set ASDE-3's range-coverage specifications. To satisfy the coverage requirements of all airports, the radar's maximum range will be 18,000 feet while its minimum range will be 500 feet if the antenna are mounted on 40 to 300 feet high towers.

3. Capabilities<sub>3/</sub>

The system will have four capabilities focused upon: (a) Integral Antenna/Rotodome; (b) Antenna Variable Focus; (c) Cosecant (CSC) Elevation Beam-Shaping; and (d) Pulse-to-Pulse Frequency Agility.

a. Integral Antenna/Rotodome

The most significant element of ASDE-3's performance is the antenna. Its signals must detect precipitation clutter, noise and azimuth resolution. An 18-foot rooftop, maximum horizontal dimension is necessary due to mounting requirements. The integral antenna/radome or rotodome would have two capacities.

First, the rotodome design benefits from the lower rainfall attenuation and backscatter coefficients at 16 GHz (gigahertz). At target range distances of approximately 2 1/2 nautical miles, improved receiver noise figures result. This allows for installation of the transmitter/receiver further away from the antenna.

3/ P.J. Bloom, J.E. Kuhn and J.W. O'Grady, "ASDE-3 -- A New Airport Surface Detection Equipment Surveillance Radar," Report No. 34/4 prepared by the Transportation Systems Center for the U.S. Department of Transportation, pp. 1-13.

b. Surveillance Information

Ground and Local Controls identify airport surface vehicles and aircraft under their jurisdiction through a surveillance information process. ASDE-3 will meet the functional specification of good surveillance in several ways. For example, the ASDE-3 display will feature diverse target-imaging and target-to-target resolution information. Active runway traffic will be spotlighted. The specific position of aircraft and/or vehicles at runway and taxiway intersections will be pinpointed. The ASDE-3 system will be able to delineate among spatially close targets, including runway and taxiway traffic. In addition, the system will identify aircraft shape and type as well as enhance airport runway and taxiway background.

To provide surveillance information, ASDE-3 will use a 15 to 20 feet radar resolution range at 0.25 degree in azimuth with an antenna rotation rate of once per second. ASDE-2 experience has provided the basis for ASDE-3's rotation rate.

c. High Resolution Presentation

ASDE-3 provides the control tower with an improved quick look aircraft and vehicle detection capability than is presently available. ASDE-3 uses a TV-vidicon scan conversion display system to permit the controller to expeditiously find and monitor interesting targets. ASDE-3 display, with near photographic quality, the total airport surface area.

Since features outside the controllers immediate field of interest, such as buildings, will be extraneous to their particular surveillance needs at a given moment, the ASDE-3 display must clearly present only the required surveillance information. To meet this standard, the ASDE-3 shall include a display enhancement unit. By using a display enhancement unit similar to a mapper, a controller achieves high resolution display presentation. The controller must be able to proportionally adjust and contrast movement versus non-movement areas with the display enhancement unit.

d. Tower for Antenna-Mounting

In order to provide line of sight surveillance information for all parts of the airport surface to tower controllers, the ASDE-3 system must be centrally located. The logical location for ASDE-3 is the control tower roof. Most control tower roofs will not support heavy additional loads or structures. Therefore, the ASDE-3 assembly must be lightweight and of compact size but still workable with numerous towers. Given the stand-

f. Testing

When the first production ASDE-3 system is delivered to a facility, the Air Traffic Service will conduct an operational acceptance test. Controller personnel will be employed to conduct the operational acceptance test. A series of tests involving different sized and shaped aircraft and vehicles will be conducted. Tests on system performance during at least moderate rain; presentation quality; data processing functions; display characteristics; target detection performance; target resolution; coverage; and surveillance accuracy will be conducted.

g. Training

In order for each facility to train its air traffic personnel in operator interface, operator manuals will be delivered along with each delivered ASDE-3.

2. Functional Specifications<sup>2/</sup>

The ASDE-3 system will have six functional specifications focused upon: (a) Weather Penetration; (b) Surveillance Information; (c) High Resolution Presentation; (d) Tower for Antenna-Mounting; (e) Antenna-Siting; and (f) Radar Coverage.

a. Weather Penetration

During periods of inclement weather, darkness or reduced visibility of the airport's surface traffic, both Ground Control and Local Control need a highly reliable, ground-mapping radar system to display vehicular activity. ASDE-3 must function best when weather conditions are the worst. Thus, ASDE-3 is designed to provide weather penetration information for the control tower 95 percent of the time when visibility is under 1 mile.

To establish ASDE-3's weather penetration limit as a function of range, at each site, the rainfall rate capability was plotted against the maximum required range. In all but two cases, at Dallas/Fort Worth (DFW) and New Orleans (MSY), the 95 percent availability rate was satisfied. In these two cases, ASDE-3 will satisfy weather penetration specifications 90 percent of the time when visibility is under 1 mile.

<sup>2/</sup> P.J. Bloom, J.E. Kuhn and J.W. O'Grady, "ASDE-3 -- A New Airport Surface Detection Equipment Surveillance Radar," Report No. 34/4 prepared by the Transportation Systems Center for the U.S. Department of Transportation, pp. 1-13.

d. Environmental

Within the tower cab, ASDE-3 associated equipment will not create an obstruction to visibility or movement. According to FAA tolerable noise level standards, no vibration will result from the sensor's operation and the noise level will be nondistractive, not to exceed the limits specified in the standards (Paragraph 3.3.1.7 of FAA-G2100C).

The most pleasing and optimum display background color for the use of controlling airport surface traffic must be used. All black hole effects will be eliminated by the design of the display. The contractor designing development of the human-machine interface will permit participation by the operational requirements team.

e. Data Processing

The ASDE-3 will be designed to accommodate data block association. It will require a totally programmable video mapper with flexible software to permit real time frame modification by local maintenance personnel. All movement areas as well as those appropriately designated by local air traffic facility management, such as ILS critical signal protection clear areas, will be outlined on the map. The mapping definition will feature consistent width and straight lines for runways or the like in order to avoid detracting from any target presentation.

To accommodate independent maps, ASDE-3 will be a split-screen system. Local operational requirements, such as the number of displays or runway configurations, will determine the number of maps. Prior to the completion of the specification, the maximum number of maps, at least one of which will be a crash grid, will be determined.

The system requires a suppression capacity and total blanking of designated areas in accordance with stored information. There will be two simultaneously available programmable independent suppression levels. The suppression mode will permit video control in designated areas by programming. The blanking mode eliminates all video in designated areas. From the console, the system will be able to receive all video in designated suppressed and blanked areas in order to locate aircraft and vehicles off movement areas. Lastly, when on or going to standby power or going back to commercial power, all data shall be retained.

b. Reliability/Availability

Including down time and scheduled maintenance, ASDE-3's operational availability will be at least 0.995. Regardless of mitigating circumstances, if ATC cannot obtain full service data from the system, ASDE-3 will be considered a failure.

c. Display

Each local and ground control position will have independent displays. Throughout the display areas, the presentation will be of constant quality. The presentation will be uniformly bright, flicker free, and clear of clutter. The presentation must be well defined and without blooming. Under all ambient light conditions, sufficient contrast and brightness plus a reflection and glare free presentation will be provided. Anywhere on the display, alphanumerics may be written.

A ten key numeric board, with variably intense back lit keys, using a standard typewriter QWERTY key board, will comprise each display. Every display key-pack unit must have character size and alphanumeric gain controls. Range scale, map selection and all other operator controls, except for brightness, contrast, and focus shall be key-pack menu driven. To locate selected menu items such as alphanumerics, a data entry device or cursor will be used. In short, the user must have immediate accessibility to all operator controls and key-pack units.

Every display requires the capacity to provide the user with independent split-screen presentations with independent range scales. Each display must have the same presentation quality as when the split-screen capacity is not used. The quality of the presentation will not be affected by the independent reverse video, operator controlled capacity of every display. Full variable and offset range will be available. After changes in the range or offset of the display, the display will recover its presentation quality within one second.

Finally, using separate operator controls, a variable target trail history, with as many as 16 scans will be provided. A greater target history capacity will be in place for runway areas instead of taxiway and/or apron areas.

For the ASDE-3 system to operate efficiently under any weather condition, multiple sensors capable of presenting all information on a common display would be acceptable. However, the area of non-return around the sensor must not exceed 500 feet in radius. In order to detect small single engine aircraft with a radar cross section of  $3m^2$ , the system shall pinpoint aircraft to a height of at least 200 feet above ground level. Given the sensor's designated coverage, the system will detect and display any and all vehicles and aircraft in its field. Aircraft moving at high speed, approximately 165 knots, must be detected by ASDE-3. The system shall indicate a displayed target position within 20 feet of the actual position of a  $3m^2$  radar cross section ground target.

ASDE-3 will distinguish between two aircraft, each with  $3m^2$  radar cross section when separated either by 80 feet in azimuth or by 40 feet in range. If two vehicles and/or aircraft are separated by 80 feet, regardless of their size, ASDE-3 must be able to resolve them. Since aircraft vary by size among small, medium and larger sized planes, the system will handle different vehicle length according to aircraft size. Three examples will suffice.

In the case of a small vehicle or an aircraft as small as a Cessna 150, ASDE-3 will delineate vehicle length up to 50 feet. For medium sized aircraft, such as a B-727 or DC-9, the system will handle vehicle length varying between approximately 90 to 160 feet. Of course, for large aircraft, including the DC-8 and B-747, ASDE-3 vehicle length delineation must exceed 180 feet.

There shall be a slant error range of no more than 50 feet. In addition, maplines will be within 12 feet of the radar received position of the runway or taxiway's actual edge.

Because ASDE-3 will be useable under all weather conditions, the system's update rate will be once per second and no second-time around or other spurious returns on the presentation are permissible. Moreover, without any presentation quality loss, the system will use an additional slave display for each of the independent master displays for system expansion to two local controls and/or two ground controls. Lastly, to the extent possible, ASDE-3 will eliminate the effects of shadowing on the movement areas inherent to most radar systems.

### III SYSTEM DESCRIPTION

"Airport Surface Detection Equipment (ASDE) - 3" is the sole NAS Plan project related to the Airport Surface Detection Equipment study area. This study area consists of one task group (TG 4-6.1) entitled "Enhanced Airport Surface Detection Equipment."

Airport Surface Detection Equipment (ASDE) - 3 is designed to prevent visibility reduction on an airport's radar caused by inclement weather. Severe precipitation, whether as rain, sleet or snow, clutters the air traffic controller's radar screen. Under hazardous weather conditions, the partially obscured radar screen limits the controller's monitoring of aircraft movement on the airport. The ASDE-3 radar system will provide controllers with accurate radar screen enhancements of service vehicles and aircraft in operation on airport runways, taxiways and/or ramps during bad weather.

#### 1. Operational Requirements<sup>1/</sup>

The ASDE-3 system will meet seven operational requirements which focus on: (a) Performance; (b) Reliability/Availability; (c) Display; (d) Environmental; (e) Data Processing; (f) Testing; and (g) Training. A full description of each operational requirement follows:

##### a. Performance

Twenty-eight airports require ASDE-3 systems. Each system will meet the particular approved airport master plan with additions. Vehicles using all existing airport movement areas, including but not limited to runways; taxiways; instrument landing system critical holding areas; ramp areas; or the like, will receive coverage. Initial installation of ASDE-3 will occur at the airports in these cities: Andrews AFB, MD; Atlanta, GA; Baltimore, MD; Boston, MA; Chicago (O'Hare), IL; Cleveland, OH; Dallas/Ft. Worth, TX; Denver, CO; Detroit, MI; Houston, TX; Kansas City, MO; Los Angeles, CA; Memphis, TN; Miami, FL; Minneapolis, MN; Newark, NJ; New Orleans, LA; New York (JFK), NY; New York (La Guardia), NY; Philadelphia, PA; Pittsburgh, PA; Portland, OR; San Francisco, CA; Seattle, WA; St. Louis, MO; Tampa, FL; Washington, (Dulles), VA; and Washington (National), VA.

<sup>1/</sup> "Airport Surface Detection Equipment (ASDE-3) Air Traffic Service Operational Requirements," Order 7032.5 (Washington, D.C.D.C.: Federal Aviation Administration, February 28, 1984), pp.1-6.

**APPENDIX C:**

**TASK GROUP 4-6.1 ENHANCED AIRPORT  
SURFACE DETECTION EQUIPMENT ADVANCE  
INFORMATION PACKAGE, SECTION III,  
SYSTEM DESCRIPTION, P. 9-17**

- (3) FIT requirements - FIT circuitry shall be 90 percent effective in isolating to a replaceable assembly (module). The achievement of FIT effectiveness shall be demonstrated.
- (4) False alarm rate requirements - FIT and BIT circuitry shall be designed to prevent the occurrence of system failure. The maximum permissible false alarm rate shall be 1 percent.

3.22 Availability.- Corrective and preventive maintenance shall not exceed 5 hours in 1-year of operation (8,760 hours) for either the local tower or the remote installation. The corrective maintenance time includes only the time required for corrective diagnosis, repair, realignment and reinitiating proper operation of the radar system. Availability predictions shall be provided as part of the documentation specified in 3.18.

4. QUALITY ASSURANCE PROVISIONS.- This section establishes the requirements and criteria for verification of ASDE system performance and design characteristics. The scope of these requirements includes the system itself, all functional areas within the system, and all internal and external interfaces. Verification is accomplished in phases throughout system acquisition. All verifications shall be accomplished to the satisfaction of the Government unless signed waivers are obtained from the Procuring Contracting Officer.

4.1 General quality assurance requirements.- The basic objectives of the quality assurance requirements are to provide early visibility of and confidence in ASDE system characteristics and performance parameters and to assist in the verification of Section 3 requirements as early as possible. The final results of the quality assurance program will be a high degree of confidence that the implemented ASDE system meets all the requirements of section 3 in its intended operational environment. Quality assurance shall be obtained by verification conducted in phases; each phase designed to provide increased assurance that required system program objectives will be met. Verification shall commence with Development Test and Evaluation (DT&E), and shall be considered complete upon satisfactory verification of required system performance during in-plant Acceptance Test and onsite Field Test and Evaluation. Objectives of an earlier verification phase must be satisfied and deficiencies must be resolved before a later verification phase is initiated. The results of each verification phase shall determine the advisability of proceeding to the next phase. The quality assurance phases shall be as follows:

- (a) Phase IA, Development Test and Evaluation, inplant,
- (b) Phase IB, Field Test and Evaluation, at a field site selected by the Government, for the first system,
- (c) Phase II, inplant test quality assurance for production of ASDE systems and quality assurance requirements for delivery, installation, and onsite test of ASDE production systems.

The tower roof equipment, the radome, pedestal and associated equipment located on either the control tower or the remote tower, shall be designed to minimize preventive and corrective maintenance actions. The tower roof equipment shall require no more than one maintenance action, corrective or preventive, per 3-month (2,190 hours) of continuous operation, exclusive of radome cleaning and recoating.

3.21 Maintainability. - The Mean Time To Repair (MTTR) shall not exceed 30 minutes. The maximum corrective maintenance time (90 percentile) for the radar system shall not exceed 1.5 hours. Maintenance (preventative or corrective) shall not be required more often than once every two months for the roof equipment. Preventive maintenance of the entire radar system, shall not be required more often than once per month. Aside from overhaul and rotodome repainting recoating, the radar system shall be designed so that each preventive maintenance action can be completed in less than 1-hour. Using the techniques of MIL-STD-470, the contractor shall submit predictions demonstrating the ability of the radar system to meet these requirements.

These predictions shall be provided as part of the documentation specified in 3.17. Repair predictions for all major elements shall be included, as well as major element overhaul time predictions, inclusive of elements such as the pedestal's rotary joint, motor, drive mechanism and bearings. The appropriate predictions shall be related to the maintainability test plan.

3.21.1 Maintainability design criteria. - Maintainability design criteria shall be in accordance with paragraph 5.4 of MIL-STD-470 and the following:

- (a) Preventive maintenance - components shall be chosen that require little or no preventive maintenance. Preventive maintenance requirements shall be determined and the schedule, procedure, and the estimated duration of each preventive maintenance task shall be reported as part of the maintainability prediction results.
- (b) Monitoring, Built-in Test (BIT), and Fault Isolation Test (FIT) - The maintenance design concept demands a built-in capability to sense, identify, and locate failures in order to achieve the required level of maintainability. The following requirements shall be applied in the establishment of design criteria:
  - (1) Failsafe requirements - BIT/FIT shall be designed to have a failure rate not exceeding 10 percent of that of the equipment being monitored. In the event of a failure in the BIT/FIT equipment, that equipment shall automatically display its failed state and shall not induce a failure in the function being monitored.
  - (2) BIT requirements - BIT circuitry shall be 95 percent effective in detecting and identifying failures in the functional loop for which it is designed. The achievement of BIT effectiveness shall be demonstrated.

**APPENDIX E:**

**EXCERPT FROM ASDE-3 — "A NEW AIRPORT  
SURFACE DETECTION EQUIPMENT SURVEILLANCE  
RADAR," P.J. BLOOM ET. AL.,  
U.S. DEPARTMENT OF TRANSPORTATION  
TRANSPORTATION SYSTEM CENTER,  
KENDALL SQUARE, CAMBRIDGE, MA. 02142,  
ABSTRACT, P. 1-3**

## EXCERPT FROM

### ASDE-3 -- A NEW AIRPORT SURFACE DETECTION EQUIPMENT SURVEILLANCE RADAR

P. J. Bloom, J. E. Kuhn, and J. W. O'Grady  
U.S. Department of Transportation  
Transportation Systems Center  
Kendall Square, Cambridge MA 02142

#### ABSTRACT

The key factor necessary for Airport Surface Traffic Control is adequate surveillance capability for the Control Tower under all operating weather conditions. ASDE is the solution for providing the surveillance capability under poor visibility conditions at most airports when the primary visual surveillance mode through the Control Tower's windows cannot be used. A new airport surface surveillance radar, ASDE-3, is currently being developed by the Federal Aviation Administration (FAA) to satisfy the Control Tower requirements.

In planning the acquisition of a new system, a number of approaches are possible. The acquisition agency could, on the one hand, simply procure the best off-the-shelf equipment available or could, on the other hand, undertake fundamental research designed to advance the state of the art and permit a quantum improvement over the best systems now available. The choice of the best approach for a particular systems development should be driven by a thorough analysis of current and future requirements for the system to be acquired. All too often, however, it is the requirement portion of systems acquisition which receives the least attention and either off-the-shelf equipment is procured, out of operational concerns for schedule, or unnecessarily complex technology is built into the new system, through the engineer's natural inclination to seek optimal performance. The new airport surface surveillance radar (ASDE-3) being developed for the FAA represents, we believe, a departure from the too much or too little rule. A concern for

properly documented user requirements and a top-down systems approach have dominated the selection of ASDE-3 parameters. Parameter optimization against requirements has been central to the design process. The results will be radar which, while representing a major improvement over the best equipment now available, avoids advanced technologies which were not necessary to meet system needs.

#### AIRPORT SURFACE TRAFFIC CONTROL SURVEILLANCE REQUIREMENTS

##### Airport Surface Traffic Control System

The Airport Surface Traffic Control (ASTC) System is defined as that system (people, procedures, and equipment) which is concerned with the movement of:

- a. Arriving aircraft through the phases of final approach, landing, and taxiing to the passenger terminal (or cargo or general aviation area, if applicable).
- b. Departing aircraft through the phases of pushback from the passenger terminal, taxiing to the departure runway, takeoff, and initial climb.
- c. Aircraft in transit between sites at the airport; e.g., from passenger terminal to cargo or maintenance area.
- d. Service or emergency vehicles; e.g., snow plows or fire engines, operating on the airport taxiways and/or runways.

The ASTC System manages the flow of vehicle movement within its jurisdiction so as to achieve the best balance for:

- 1) Maximizing safety and quality of service.
- 2) Minimizing aircraft delays and fuel use.
- 3) Minimizing air pollution and noise.

- 4) Minimizing costs incurred by airport operators, users, and participating local, state, and Federal government agencies.

Airport Surface Traffic Control is exercised from the Control Tower Cab that is situated above the airport to provide good visual coverage. In general, two control positions are involved; Ground Control for taxiway network control and Local Control for runway management including landing clearance, takeoff clearance, and runway crossing clearance.

#### Surveillance, the Key Factor

Surveillance is the process whereby Ground and Local Controls acquire information on the position and identity of vehicles under their jurisdiction. The Ground Controller uses visual observation, through the windows of the tower cab, as this primary means of surveillance. The Local Controller uses visual observation and the Airport Surveillance Radar (ASR) as his primary surveillance media. The ASR, which provides a radar-derived display of the positions and associated identities of airborne aircraft in the vicinity of the airport, is used to monitor aircraft on final approach or initial climb. Airport Surface Detection Equipment (ASDE-2), a high resolution, ground-mapping radar is available at 12 airports. The function of an ASDE is to provide a display of airport surface traffic activity for use by the Ground and Local Controllers during conditions of reduced visibility due to weather or darkness.

The Transportation Systems Center (TSC) has conducted extensive analyses of the ASTC System and has concluded that its principal problems, both today and through the 1980's, relate to surveillance under poor visibility conditions. Although other elements of the system such as the communication and control functions do exhibit problems, these problems appear to be induced by the deficiencies of the surveillance system and do not warrant extensive non-surveillance-related system developments

such as automation of the Control or Communications functions.

ASDE, the Surveillance Solution at Most Airports

Without an ASDE, the Controllers experience difficulties during poor visibility conditions, and must rely on pilot position reports via VHF radio. For the Local Controller, the principal problem is the loss of timing information regarding runway operations. In general, the distribution of arrival traffic is determined by the Approach Controller in the IFR room. The Local Controller's problem then is to fit his departure traffic into the release opportunities afforded by the distribution of arrival traffic. This is particularly important where a single runway is used for mixed arrival and departure traffic or where the arrival and departure runways intersect. In the absence of an ASDE, poor visibility forces Local Control to rely on imprecise pilot-position reports. This results in loss of runway capacity of, for example, approximately 25 percent for the single mixed runway case. The plan view ASDE display provides position and timing information on runway traffic and on arrival and departure aircraft up to an altitude of about 150 feet. With an ASDE, therefore, runway capacity in poor visibility can be restored to within about 5 percent of the good visibility capacity for the single mixed runway case. Lack of identifying information on the ASDE display has little significance for Local Control since his traffic is ordered and sequential, allowing ready correlation between the ASDE position information and flight strip identity.

For Ground Control, timing information is not critical but information on position and identification is. Of the 50 percent or so capacity loss experienced by Ground Control because of poor visibility, only about a third of this lost capacity is restored by use of an ASDE radar. The principal problem is the correlation of radar position information with vehicle

identification. The Ground Controller's traffic is not well ordered, and significant VHF radio traffic is required during poor visibility conditions to maintain position/identity correlation on the ASDE display. This VHF traffic tends to drive the Ground Controller's radio channel into saturation and substantially reduce the controller's capacity.

Fortunately, except for exceptional circumstance, it is the Local Control (runway capacity), and not Ground control capacity, which limits airport traffic-handling capability. Thus, an ASDE-equipped Ground Controller can match the capacity of an ASDE-equipped Local Controller under poor visibility, despite loss of the Ground Controller's capacity relative to his good weather performance. The exception to this rule is an airport which operates more than one Category II runway in poor visibility with a net arrival/departure rate exceeding 65 operations per hour. For those few airports (approximately six U.S. airports by 1985) something beyond ASDE is required to provide position and identity. Such a system (called TAGS) is under development by TSC and has been reported previously. For most airports (30 to 40), which need poor visibility surveillance augmentation, ASDE provides the required capability at considerably less cost than TAGS.

Having discussed the role of an ASDE in control tower operations, let us now consider what is required for the ASDE if it is to fulfill that role successfully.

#### ASDE DESIGN CONSIDERATIONS

##### Weather Penetration, a Primary Requirement

The role of an ASDE, as discussed previously, is to provide the alternative means of airport surveillance for the Control Tower when visibility through the Tower windows is restricted. The most persistent complaint of Controllers regarding ASDE-2 has been that it works best when they do not need it, and works worst when they need it the most. Since visibility restrictions

are caused by weather, weather penetration is a primary ASDE requirement. The ASDE-3 weather penetration (rainfall rate) requirement is based on several factors including climatic data for candidate airports, visibility effects of weather, the operational availability needed for reliable surveillance, and the performance which can reasonably be achieved by an ASDE radar.

Over 30 airports have been identified as ASDE-3 candidates using the FAA ASDE establishment criteria. Available climatic data for 21 airports slated to receive ASDE-3 were analyzed to determine the rainfall rate capability required at each airport to assure ASDE surveillance availability for the Control Tower 95 percent of the time when visibility is under 1 mile.

**APPENDIX F:**

**AIR TRAFFIC CONTROLLER'S HANDBOOK,  
FAAH 7110.65D, CHAPTER 3, SECTION 6,  
AIRPORT SURFACE DETECTION PROCEDURES, P. 3-13**

## Section 6. AIRPORT SURFACE DETECTION PROCEDURES

### 3-70 EQUIPMENT USAGE

Use ASDE to augment visual observation of aircraft and/or vehicular movements on runways and taxiways:

- a. When visibility is less than the most distant point in the active movement area, and
- b. When, in your judgment, its use will assist you in the performance of your duties at any time.

### 3-71 INFORMATION USAGE

#### a. Use ASDE-derived information:

(1) To determine that the runway is clear of aircraft and vehicles prior to a landing or departure.

3-71a(1) Reference. — Order 7210.3 - 371, Radar Use.

(2) To monitor compliance with control instructions by aircraft and vehicles on the taxiways and runways.

(3) To confirm pilot reported positions.

(4) To provide directional taxi information on pilot request.

#### Phraseology:

TURN (left/right) ON THE TAXIWAY/RUNWAY YOU ARE APPROACHING.

b. Do not provide specific navigational guidance (exact headings to be followed) unless an emergency exists or by mutual agreement with the pilot.

3-71b Note. — It remains the pilot's responsibility to navigate visually via routes to the clearance limit specified by the controller and to avoid other parked or taxiing aircraft, vehicles, or persons in the movement area.

### 3-72 IDENTIFICATION

To identify an observed target on the ASDE display, correlate its position with one or more of the following:

- a. Pilot's report.
- b. Controller's visual observation.
- c. An identified target observed on the ASR bright display.

3-73 thru 3-79 RESERVED

**APPENDIX G:**

**FAA ORDER 7032.5, AIRPORT SURFACE  
DETECTION EQUIPMENT (ASDE-3)  
AIR TRAFFIC SERVICE OPERATIONAL REQUIREMENTS,  
P. 1-6**

**ORDER**

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION

7032.5

2/28/84

**AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3) AIR TRAFFIC SERVICE  
SUBJ: OPERATIONAL REQUIREMENTS**

1. PURPOSE. This order establishes the Air Traffic Service operational requirements for the ASDE-3.
2. DISTRIBUTION. This order is distributed to the branch level in the Air Traffic, Program Engineering and Maintenance, and Systems Engineering Services, Technical Center, regional Air Traffic Divisions and to the Aeronautical Center, air route traffic control centers, military liaison officers and Level IV and V terminals.
3. APPLICATION. This order applies to all Air Traffic Service personnel and is for the guidance of all other organizational units.
4. MISSION NEED. The primary need for an ASDE is to obtain positive surveillance and assist in expediting aircraft flow during restricted visibility conditions. The following are examples of the use of ASDE by controllers on a continuing basis during periods of restricted visibility:
  - a. Ascertain that departing aircraft have taxied into position for takeoff on the proper runway of two close parallel runways when arriving aircraft are on final approach for landing on the adjacent runway.
  - b. Ascertain that taxiing aircraft are not inadvertently entering an active runway during restricted visibility conditions when the pilot may not be able to see adequately to determine that he is holding short of a runway.
  - c. Assist the ground controller in preventing collision situations, and providing an orderly movement of aircraft and ground vehicles on the airport surface when visibility restrictions prevent the controller, pilots, or vehicle operators from seeing other ground traffic on the airport.
  - d. Determine that runways are not occupied by other aircraft, ground vehicles, or other obstructions prior to issuing takeoff/landing clearance to departing/landing aircraft.
  - e. The ASDE is, to some extent, used at night to determine positions of aircraft where the distance to the end of the runway and the flat viewing angle from the tower cab do not allow the controller to visually determine relative positions of aircraft awaiting takeoff.
5. PROBLEM DEFINITION. The ASDE-2 now used at several major airports has been operational for the past 20 years. Being a vacuum tube design, it has had a maintenance problem with tube failures, resulting in a mean time between failures

Distribution: A-W(AT,PM,ES)-3; A-X(AT)-3; A-Y-1; A-Z-3; A-FAT-1-7(STD); A-FAT-2,8 (Level IV and V only) Initiated By: AAT-150

rate of approximately 200 hours. In addition, the radar is nearly useless in heavy rain due to backscatter from rain droplets, resulting in a whiteout and absorption of signals at its emitted frequency by the rain.

6. SYSTEM DESCRIPTION. The ASDE-3 will be a high resolution ground mapping radar that shall provide the local and ground controllers in the control tower a clear, accurate, and bright presentation of airport runways, taxiways, and aprons, and of any stationary or moving aircraft or vehicles on these surfaces under all weather conditions.

7. OPERATIONAL REQUIREMENTS.

a. Performance.

(1) The system must provide coverage for all existing movement areas (runways, taxiways, instrument landing system critical holding areas, etc.) and airport master plan approved additions for the following airports:

- (a) Denver, CO
- (b) Dallas/Ft. Worth, TX
- (c) Los Angeles, CA
- (d) Atlanta, GA
- (e) Chicago (O'Hare), IL
- (f) Boston, MA
- (g) New York (JFK), NY
- (h) San Francisco, CA
- (i) Miami, FL
- (j) Cleveland, OH
- (k) Washington (National), VA
- (l) Pittsburgh, PA
- (m) St. Louis, MO
- (n) Philadelphia, PA
- (o) Memphis, TN
- (p) New York (LaGuardia), NY
- (q) Houston, TX
- (r) Minneapolis, MN
- (s) Detroit, MI
- (t) Tampa, FL
- (u) Seattle, WA
- (v) Baltimore, MD
- (w) Newark, NJ
- (x) Portland, OR
- (y) New Orleans, LA
- (z) Kansas City, MO
- (aa) Washington (Dulles), VA
- (bb) Andrews AFB, MD

Note: This requirement may be satisfied by multiple sensors capable of presenting all information (and/or any part) on a common display.

(2) The area of nonreturn around the sensor shall not have a radius of greater than 500 feet.

(3) The system shall be capable of detecting aircraft (whose radar cross section (RCS) is  $3 \text{ m}^2$  (estimated RCS of a small single engine aircraft)) up to a height of 200 feet above ground level.

(4) The system shall be capable of detecting and displaying all aircraft/service vehicles/etc., within the sensor's designated coverage.

(5) The system shall be capable of detecting high speed (165 knots) aircraft.

(6) The actual position of a  $3 \text{ m}^2$  RCS target on the ground shall be within 20 feet of the displayed target position.

(7) The system must be capable of distinguishing two aircraft having  $3 \text{ m}^2$  RCS each, when separated by 40 feet in range or 80 feet in azimuth. The system must also be capable of resolving two aircraft and/or vehicles, regardless of size, when separated by 80 feet.

<u>Size</u>	<u>Vehicle Length</u>
(a) Small aircraft (Cessna 150 or vehicle)	Up to 50 feet
(b) Medium aircraft (B-727/DC-9)	90 to 160 feet
(c) Large aircraft (B-747/DC-8)	180 feet and above

(8) The slant range error shall not exceed 50 feet.

(9) The map lines shall be within 12 feet of the radar received position of the actual edge of the runways, taxiways, etc.

(10) The system shall provide an update rate of once per second.

(11) There shall be no evidence of second-time-around or other spurious returns on the presentation.

(12) The system shall be useable (within the limits stated in this order) during all weather conditions.

(13) The capability shall exist for slaving an additional display from each of the independent displays for system expansion (two local controls and/or two ground controls) without any loss in presentation quality.

(14) Eliminate, to the extent possible, the effects of shadowing on the movement areas. Note: Due to the inherent nature of radar, we recognize shadowing cannot be totally eliminated.

b. Reliability/Availability. The operational availability of the ASDE radar system shall be at least 0.995. This figure shall be calculated using all down-time, including scheduled maintenance. The ASDE system is considered to have failed when ATC can no longer provide full service through data obtained from the ASDE. This includes loss or degradation of performance outside the limits stated in this order, regardless of the location of the sensor, weather conditions, or whether on main or standby power.

c. Display.

(1) Independent displays at each local and ground control position shall be provided.

(2) The quality of the presentation shall be constant throughout the display area, clear of clutter, flicker free, and of uniform brightness.

(3) The presentation shall be well defined and blooming eliminated.

(4) The presentation shall provide sufficient contrast and brightness under all ambient light conditions and must be free of reflection and glare.

(5) The display presentation shall be rectangular with a diagonal of no less than 14 inches.

(6) The system shall provide the capability to write alphanumerics anywhere on the display.

(7) Each display shall have an associated QWERTY keyboard (standard typewriter keyboard) with a ten key numeric board and have back lit keys with variable intensity.

(8) Each display key-pack unit shall have an alphanumeric gain and character size controls.

(9) All operator controls (range scale, map selection, etc.) will be key-pack menu driven, with the exception of focus, contrast, and brightness.

(10) There shall be a data entry device (cursor) to locate selected menu items (e.g., alphanumerics, off-center, etc.).

(11) All operator controls and key-pack units shall be immediately accessible to the user.

(12) Each display shall have the capability of independent split-screen presentations with independent range scales, and shall have the same presentation quality as when the split-screen capability is not in use.

(13) Each display shall have independent reverse video capability, operator controlled and shall not affect the quality of the presentation.

(14) Full variable range and range offset shall be provided.

(15) After changing the range, offset, etc., the display shall recover its presentation quality within 1 second.

(16) A variable target trail history of up to 16 scans shall be provided with separate operator controls. Runway areas shall have a greater target history capability than taxiway/apron areas.

d. Environmental.

(1) Equipment associated with the ASDE shall not create an obstruction to visibility or movement within the tower cab.

(2) The operation of the sensor shall result in no vibration and the noise level must be nondistractive and shall not exceed the limits specified in paragraph 3.3.1.7 of FAA-G-2100C (FAA standards for tolerable noise levels).

(3) The display background color shall be the most pleasing and optimum for use of controlling airport surface traffic.

(4) The display shall be designed in such a manner that will eliminate all black hole effects.

(5) The contractor shall allow participation by the operational requirements team in the design development of the human-machine interface.

e. Data processing.

(1) This system shall not be designed in a way that would preclude the capability of accommodating data block association.

(2) The video mapper shall be completely programmable with software flexibility to allow for modification in a realistic time frame by local maintenance personnel. The map shall be able to outline all movement areas and any other areas deemed appropriate by local air traffic facility management (e.g., ILS critical signal protection clear areas). The mapping shall be of such definition so as to not detract from any target presentation, be of consistent width and, when appropriate, appear as straight lines (i.e., runways, etc.).

(3) The split-screen system shall have the capability of accommodating independent maps. The number of maps will be determined by local operational requirements (e.g., runway configurations, number of displays, etc.). The maximum number of maps, one of which shall be a crash grid, shall be established prior to completion of the specification.

(4) The system shall have the capability of suppression and total blanking of designated areas in accordance with stored information. Two programmable independent levels of suppression shall be simultaneously available.

(a) Suppression - allows control of video in designated areas by programming.

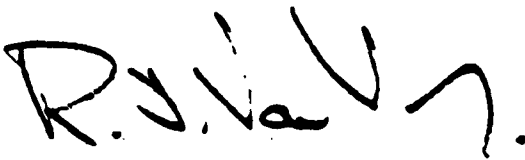
(b) Blanking - eliminates all video in designated areas.

(5) The system shall have the capability, from the console, of receiving all video in designated suppressed and blanked areas for the purpose of locating aircraft and vehicles off movement areas.

(6) All data shall be retained when on or going to standby power (or going back to commercial power).

f. Testing. The Air Traffic Service shall conduct an operational acceptance test on the first production system delivered to a facility. The operational acceptance test will employ controller personnel and will include a series of tests involving different sized and shaped aircraft and vehicles. Some of the areas the tests will concentrate on will be surveillance accuracy, target resolution, coverage, target detection performance, display characteristics, data processing functions, presentation quality, and system performance during at least moderate rain.

g. Training. Upon delivery, operator manuals shall be provided to each facility for the purpose of training air traffic personnel in operator interface.



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Associate Administrator  
for Air Traffic

**APPENDIX H:**

**TASK GROUP 4-6.1 ENHANCED AIRPORT  
SURFACE DETECTION EQUIPMENT ADVANCE  
INFORMATION PACKAGE, SECTION VI,  
REFERENCES, P. 19-20**

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